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Kootenai River White Sturgeon Investigation

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July 1995

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KOOTENAI RIVER WHITE STURGEON INVESTIGATION

ANNUAL PROGRESS REPORT

Period Covered: January 1, 1994 to December 31, 1994

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ABSTRACT

The U.S. Army Corps of Engineers in concordance with Bonneville Power Administration provided a release of 1.48 billion cubic meters (1.2 MAF, million acre feet) of impounded water from Lake Koocanusa, Montana from June 1 to June 28, 1994. This release of water provided approximately 566 m^3/s (20 thousand cubic feet per second, kcfs) discharge in the Kootenai River at Bonners Ferry, Idaho.

Between February and early April 1994, 15 adult sturgeon (10 females, 5 males) in late vitellogenic stage were captured and fitted with combinations of radio and sonic transmitters. A total of 31 sturgeon were monitored.

As spring runoff flows increased in late April and early May, 12 transmittered sturgeon (8 females, 4 males) moved upriver to Shorty's Island (river kilometer [rkm] 230.1). Of these, 7 (3 females, 4 males) eventually moved upriver to Myrtle Creek (rkm 237.3). Their activities at the egg collection sites suggested they joined other spawning sturgeon. Four transmittered fish (3 females, 1 male) moved upriver to, but not beyond, Fleming Creek (rkm 225). No transmittered sturgeon were recaptured to verify spawning.

Age estimates of fin ray sections from 18 107-137 cm (42.8-54.8 in) sturgeon ranged from 20 to 32 years. The growth rate of sturgeon between initial capture and multiple recaptures averaged 3.2 cm (1.28 in) per year.

Between March 1993 and July 1994, 44,333.5 hours of effort were targeted on capture of juvenile sturgeon. Seven gear types collected a total of 16 adult and 5 juvenile sturgeon. All juveniles were from the 1991 year class. Four were assumed wild fish and one originated from a 1992 hatchery release. A total of 325 fish of various other species were collected. No sturgeon eggs or larvae were found in those stomachs examined.

D-ring, beam trawl tows, and artificial substrate mats were used to sample white sturgeon'eggs and larvae. No sturgeon eggs or larvae were found in 101.3 hours of beam trawling, 15 hours of seiving the water column, and 1,215.25 hours of sampling near the river substrate. Artificial substrate mat samples, totaling 1,940, were distributed in 17.6 km (10.9 mi) of river between Bonners Ferry and Shorty's Island. A total of 213 white sturgeon eggs were collected during 58,947 hours of sampling for a catch rate of .004 eggs/h. At least eight spawning events were documented between May 15 and June 20, at two locations near Shorty's Island, and one location near the confluence of Myrtle Creek. Water velocities averaged .32 m/s (1.05 ft/s) at egg collection sites.

Ten hatchery reared juvenile white sturgeon equipped with radio and sonic tags were released in pools downriver of Kootenai Falls, Montana. All ten sturgeon had moved between 60 and 97 km (37.3 and 60.3 mi) downriver of release sites within one month. Movements coincided with major flow peaking associated with hydropower production at Libby Dam, located upriver of the release site.

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INTRODUCTION

Data collected during ten years of white sturgeon Acipenser transmontanus investigations on the Idaho portion of the Kootenai River (Figure 1), five years on the Montana portion, and four years in British Columbia, Canada, suggested very little spawning was occurring. Studies of white sturgeon spawning in the Columbia River system reported water temperatures of 14°C to 17°C (57.2°F to 62.6°F), suitable water depths of at least three meters (±10 ft) and a discharge with velocities of at least 0.5 m/s (1.6 ft/s) over a substrate of bed rock, cobble, or gravel were required for successful reproduction of white sturgeon. Prior to 1972 and the operation of Libby Dam, the Kootenai River had suitable habitat for a self-sustaining population of white sturgeon. A sample of 185 adult sturgeon examined between 1977 and 1980 revealed 79% (144) of the 185 fish were 15-27 years old. Thus, the majority of this sample of 185 fish were hatched between the years 1951 and 1965. Hydrographic records indicated these were wet years with better than average run-off. Historic pre-dam flows ranged from 1,699 to 2,832 m^3/s (59,992 to 99,998 cfs) during the sturgeon spawning period. Peak flows, during April through July, of the Kootenai River after Libby Dam were generally in the 250 to 450 m^3/s (8,828 to 15,890 cfs) range (Apperson and Anders 1991).

The Bonneville Power Administration and United States Army Corps of Engineers provided 1.48 billion m^3 (1.2 MAF million acre feet) of water stored in Libby Reservoir (Lake Koocanusa) to produce a discharge in the river at Bonners Ferry of 566 m^3/s (20,000 cfs) during the spring of 1994. This document summarizes the movements and spawning behavior of white sturgeon in the Kootenai River prior to and during this experimental discharge period.

STUDY SITE

The Kootenai River originates in Kootenay National Park, British Columbia. The river flows south into Montana and turns northwest at Jennings, the site of Libby Dam, at rkm 352.4 (Figure 1). Kootenai Falls, 40 km (24.8 mi) below Libby Dam, presents an impassable barrier to sturgeon. As the river flows though the northeast corner of Idaho, a definite change occurred at Bonners Ferry. Upriver from Bonners Ferry, the channel has an average gradient of 0.6 m/km (3.15 ft/mi), with velocities higher than 0.8 m/s (2.6 ft/s). Downriver from Bonners Ferry the river slowed with velocities less than 0.4 m/s (1.3 ft/s). Average gradient declines of 0.02 m/km (.1 ft/mi), the channel deepens and the river meanders though the Kootenai Valley back into British Columbia and enters the southern arm of Kootenay Lake. The river leaves the lake though the western arm to its confluence with the Columbia River at Castlegar. A natural barrier at Bonnington Falls (now a series of four dams) have isolated the Kootenai white sturgeon from other populations in the Columbia River basin for approximately 10,000 years (Northcote 1973). The basin drains an area of 49,987 km^2 (19,300 mi^2) (Bonde and Bush 1975).

OBJECTIVE

1. Determine environmental requirements for adequate spawning and recruitment of white sturgeon by **1998.**

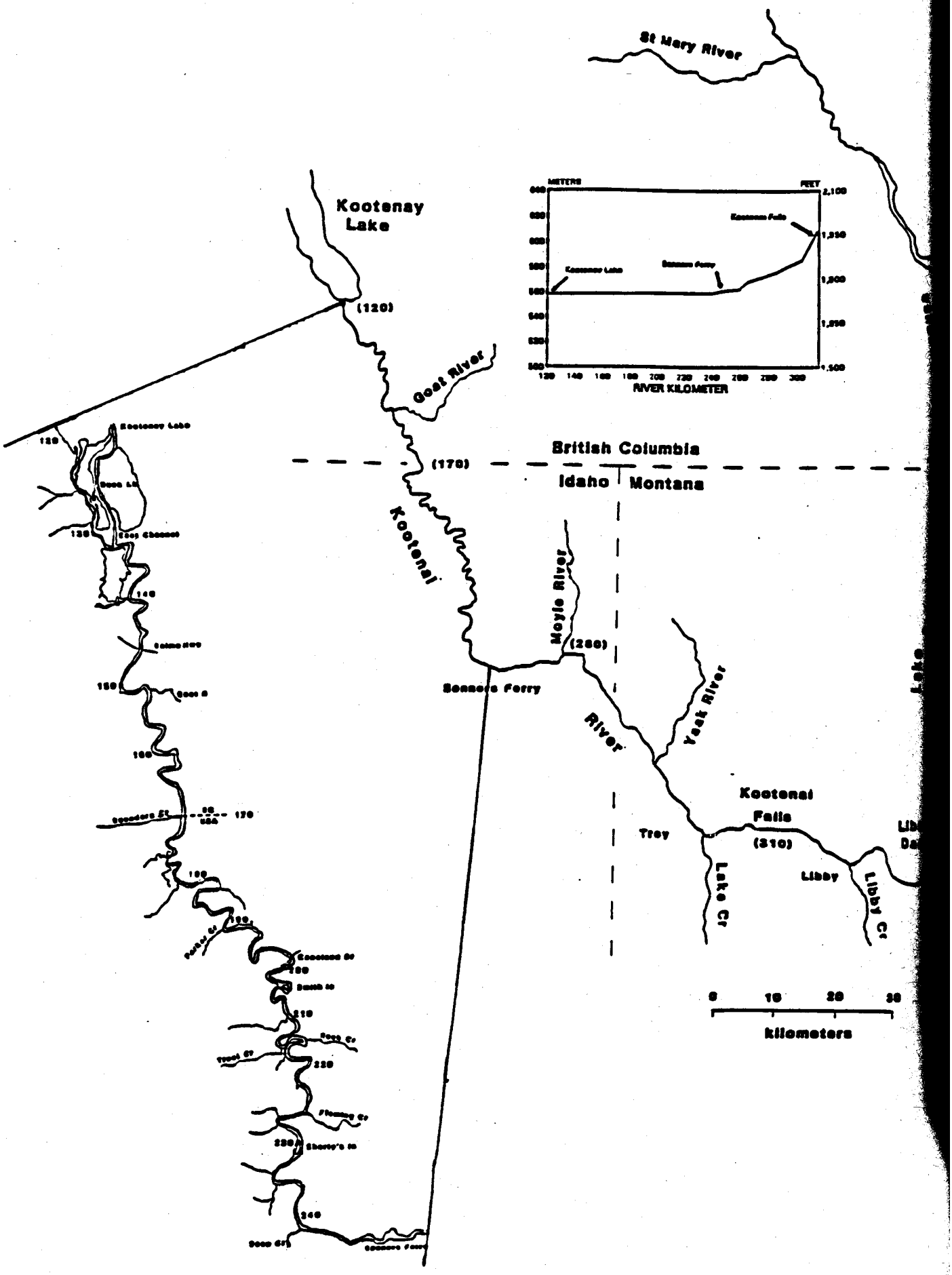


Figure 1. Map of the Kootenai River with a schematic of river gradient and notable points of reference from Bonners Ferry to Kootenay Lake. Complete study area was from southern Kootenay Lake upriver to Kootenai Falls.

Table 1. Sexual development of white sturgeon sampled in the Kootenai River, Idaho 1989 though 1994.

Categories of sexual development		Percent (number) of sample by year					
Category/sex	Description of development	1989	1990	1991	1992	1993	1994
0/Unknown	Gonad undifferentiated or not seen	32 (58)	14 (15)	6 (3)	2 (1)	0	31 (18)
1/Female	Previtellogenic: no visual signs of vitellogenesis; eggs present but have average diameter <0.5 mm	14 (25)	12 (13)	8 (4)	12 (5)	0	5 (3)
2/Female	Early vitellogenic: eggs are cream to gray; average diameter 0.6 to 2.1 mm	7 (12)	7 (8)	4 (2)	2 (1)	5 (1)	2 (1)
3/Female	Late vitellogenic: eggs are pigmented and attached to ovarian tissue; average diameter 2.2 to 2.9 mm	6 (10)	5 (5)	8 (4)	9 (4)	53 (10)	0
4/Female	Ripe: eggs are fully pigmented and detached from ovarian tissue; average diameter 3.0 to 3.4 mm	2 (3)	5 (5)	4 (2)	9 (4)	11 (2)	12 (7)
5/Female	Spent: gonads are flaccid and contain some residual fully pigmented eggs	3 (5)	1 (1)	2 (1)	0	5 (1)	0
6/Female	Previtellogenic with attritic oocytes: eggs present but have an average diameter <0.5 mm; dark pigmented tissue present that may be reabsorbed eggs	2 (3)	0	0	0	0	0
R/Female	Reabsorbing eggs	0	0	0	2 ([1])	0	0
7/Male	Non-reproductive: testes with translucent smokey pigmentation	3 (6)	27 (30)	29 (15)	26 (11)	0	18 (10)
8/Male	Reproductive: testes white with folds and lobes	32 (58)	28 (31)	18 (9)	16 (7)	21 (4)	32 (18)
9/Male	Ripe: mik flowing; large white lobular testes	0	3 (3)	14 (7)	21 (9)	5 (1)	5 (9)
S/Male	Spent: testes flaccid; some residue of milt	0	0	8 (4)	0	0	0

METHODS

Discharge and Water Temperature

The discharge formula for the Kootenai River at Bonners Ferry was calculated by the U.S. Army Corps of Engineers (Pat McGrain, personal communication). The instantaneous discharge of the Kootenai River at Bonners Ferry was calculated from a reading of the discharge at Leonia gauge six hours earlier + 1.25 x Yaak River gauge three hours earlier. Six hours was considered the time water from Leonia reaches Bonners Ferry, a distance of 30.2 km (18 mi). The travel time for water at Moyie to Bonners Ferry was three hours. The one (1), in the formula, was the gauge at Yaak River which had essentially the same drainage area of the Moyie (Yaak = 198 ha^t, Moyie 196 ha^2) and approximately the same mean annual discharge (Yaak = 24.4 m^3/s, Moyie 25.1 m^3/s). The .25, in the formula, is the balance of local waters between Leonia and Bonners Ferry.

Water temperatures were recorded at the U.S. Geological Survey Gauging station at the U.S. Highway 95 bridge in Bonners Ferry. The Bonneville Power Administration and U.S. Army Corps of Engineers proposed a flow design to encourage white sturgeon to spawn in the Kootenai River with the following criteria:

1. Maintain a minimum spring run-off of 425 m^3/s (15 kcfs).
2. Provide 566 m^3/s (20 kcfs) for 35 days when waters temperatures approach 12°C to 13°C (53.6°F to 55.4°F).
3. Provide flows of 311.5 m^3/s (11 kcfs) for 30 additional days in July to early August.
4. Eliminate load following.

Adult Sturgeon Sampling

Adult white sturgeon were captured with rod and reel or setlines from 1989 to April 1994. Fish over 120 cm (48 in) were examined surgically to determine gender and stage of sexual maturity as classified in Table 1. Radio (24-month) and ultrasonic transmitters (50-month) were fitted on ten females and five males captured between February and early April 1994. All transmitters were attached with 1.4 mm (.055 in) wire leader and crimps though the proximal portion of the dorsal fin.

Locations of each transmitter were recorded to the nearest 0.1 rkm (.06 mi) for each fish. Two to three intersecting headings from different points in the river or lake were used to triangulate the fish's position. Once a fish's specific location was determined, the boat was moved to a position upriver from the fish to avoid startling it. We then drifted the boat over the fish's location with the motor off. The depth and water temperature were measured with an echo sounder and hand-held thermometer. A stationary radio data logger was mounted along the riverbank between Ambush Rock and the U.S. Highway 95 bridge (rkm 245.8) to monitor any migration in the river near Bonners Ferry, Idaho.

Fork length (FL), total length (TL), and weight (kg) were recorded for each sturgeon. A total of 18 pectoral fin samples were collected from smaller sturgeon <137 cm (54 in) in 1994. Fin rays were cut into thin sections, sanded smooth, and viewed under a dissecting microscope to determine ages. Fish collected in early spring prior to annulus formation were assumed to have an annulus on the outer edge of the ray. Average ages were calculated from individual age estimates made by three or more readers. Examinations of white sturgeon included searching for previous tags and inserting Passive Int

egrated

Transponder (PIT) tags. Recaptured females were usually surgically re-examined for sexual development unless the data base revealed surgery had been performed within the same year.

White Sturgeon Egg and Larvae Sampling

We used artificial substrate mats to document white sturgeon spawning. Substrate mats consisted of filter material (latex-coated animal hair) bolted to 62 x 75 cm (24.8 x 30 in) angle iron frames (McCabe and Beckman 1990). Mats were held in position on the substrate by the weight of the frame and an anchor. An orange buoy with an identification number was attached to each mat. Mats were set in the river from May 10 to July 20, 1994. Mats were deployed in the river from Shorty's Island to U.S. Highway 95 bridge (rkm 228 to 246). Mats were set at various depths and locations in respect to locations and movement of radio-tagged adult sturgeon that were potential spawners in 1994. Time, depth, and location of mats were recorded at deployment and retrieval. Mats were retrieved to the boat by pulling the line from an attachment point fixed to the downriver side of the mat frame to minimize flushing of contents. Mats were pulled and examined for presence of eggs daily until the end of June,. after which they were checked every 2-4 days through July 20.

Eggs were removed from mats and stored in labeled vials containing formalin or alcohol solution. White sturgeon spawning dates and times (±4 hours) were back-calculated from all viable white sturgeon eggs using an exponential function involving water temperature and embryonic development described by Wang et al. (1985) and Beer (1981). Embryonic stages of white sturgeon eggs were distinguished visually and with a dissection microscope using the embryological criteria developed by Beer (1981). Spawning dates or times could not be estimated for non-viable and unfertilized white sturgeon eggs.

Surface and bottom velocities were recorded at some egg collection sites. Several eggs were deployed in containers within the river or taken to the Kootenai Tribes experimental hatchery for observation of development.

We sampled for sturgeon eggs and larvae between May 24 and July 1, 1994 with two types of trawl nets. A beam trawl (3 m x 1.0 m, 1.59 mm knotless mesh) and D-ring plankton nets (0.78 m maximum width x 0.54 m high, 1.59 mm knotless mesh) were utilized. The nets were held stationary on the substrate for 3 to 30 minutes per sample. Detailed methodology and gear specifications are given by Parsley et al. (1989). D-ring nets were fished at 277 samples on the Kootenai River between rkm 225 and 270, May 18 to July 27, 1994. Two hundred ninety-eight beam trawl collections were made at 15 locations between the railway bridge (rkm 245.7) and lower end of Shorty's Island (rkm 228). Two D-ring nets were usually fished simultaneously. A standard sample consisted of fishing nets for 5 to 30 minutes depending on the amount of organic debris in the drift. Sites chosen to sample white sturgeon eggs and larvae were immediately downstream from suspected spawning habitat and the locations of late vitellogenic white sturgeon fitted with transmitters. Site selection for trawl sampling locations used the same criteria as D-ring nets. General Oceanics Flow meters were mounted on all trawl gear to monitor volume of water filtered.

We searched for yearling and older juvenile sturgeon in several types of Kootenai River habitats. Slat traps, 61 cm (2 ft) and 91 cm (3 ft) baited hoop nets, multifilament gill nets, setlines equipped with 6/0 hooks, minnow traps, and rod and reel gear were employed. Suckers, Catostomus sp., squawfish Ptychocheilus oregonensis, and peamouth Mylocheilus caurinus collected during the month of June had their stomach contents analyzed for the occurrence of sturgeon larvae or eggs.

Hatchery Reared Juvenile Release

On September 29, 1994, two groups of five 1992 year class juvenile sturgeon were released in the Kootenai River below Kootenai Falls. Release sites were located at rkm 305.4 and in four pools between rkm 307.3 and 310.5. Each sturgeon was tagged with a sonic and a radio tag, a removal of the 2nd left and 9th right scute, an orange Floy tag, and a PIT tag. Sturgeon were tracked with sonic and radio receivers for the seven days after release, and every other day thereafter until the end of October. Weights and lengths were recorded on the day of release for each fish.

On July 29, 1994, 38 juvenile sturgeon were released at Ambush Rock (rkm 244.5). On August 4, 1994, 40 juvenile sturgeon were released at Ferry Island (rkm 203.6). These juveniles were PIT and Floy tagged and a scute was removed as an external mark. Monitoring of the releases was conducted by the Kootenai Indian Tribe and should to be reported in their Annual Report to the Bonneville Power Administration.

RESULTS

Discharge and Temperature

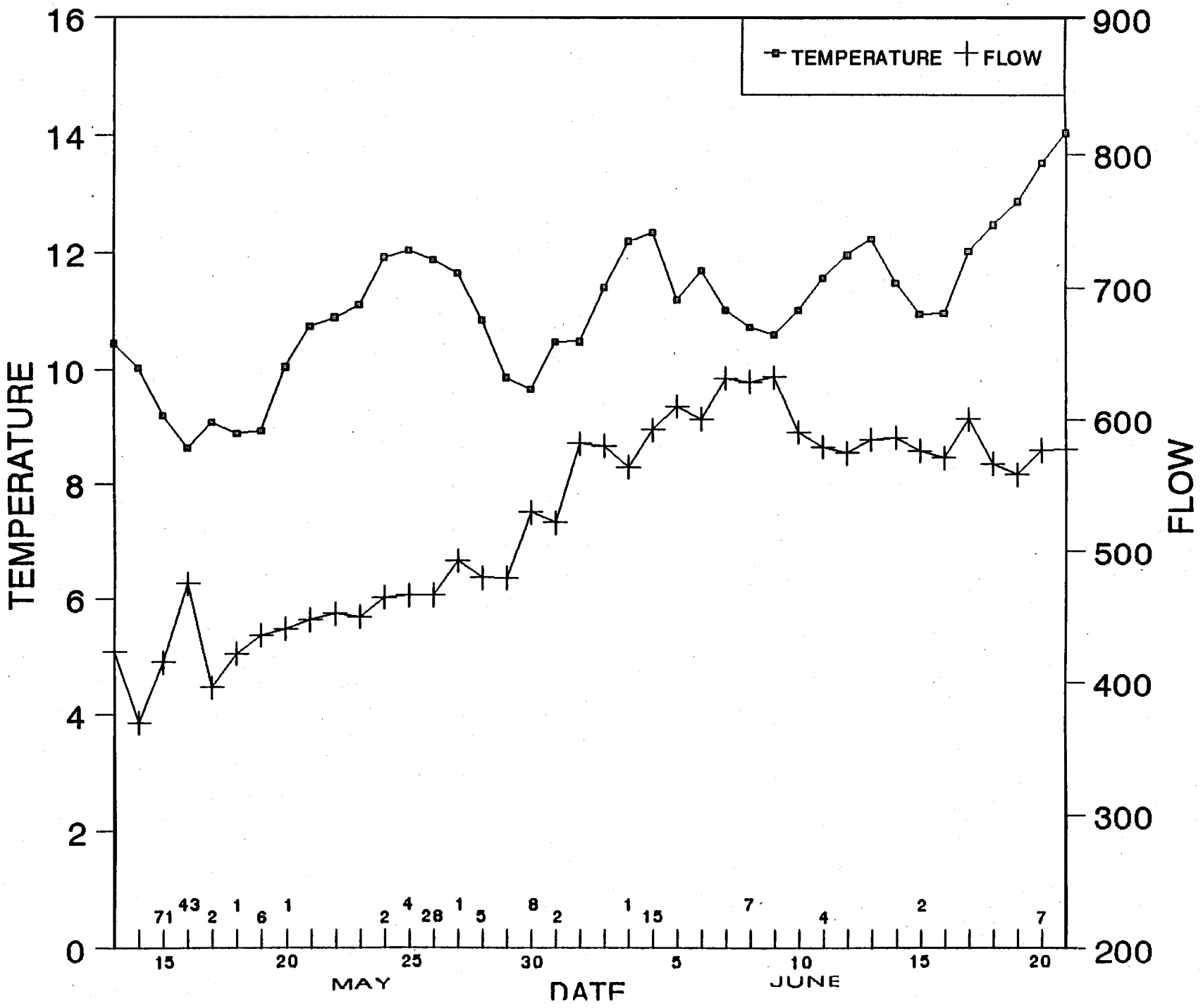
The flow criteria proposed by the U.S. Corps of Engineers was altered to a slightly earlier augmentation date based on the spawning behavior of tagged adult white sturgeon. The 1.48 billion m^3 (1.2 MAF) of water on reserve for sturgeon began on May 6 and ended July 11, 1994. Natural spring runoff below Libby Dam (local inflow) peaked at 581 m^3/s (20,505 cfs) on April 22 at Bonners Ferry (Figure 2). Waters subsided to a low of 277 m^3/s (9,785 cfs) before flow augmentation was initiated. Due to the upriver locations of the bulk of monitored fish, we decided on May 7, 1994 to add discharges in small increments to the target of 566 m^3/s (20,000 cfs). The target flow of the test was reached on June 1 and ended June 28. Flows fluctuated between 557 and 633 m^3/s (19,677 and 22,347 cfs). Minor deviations from the 566 m^3/s (20,000 cfs) target were a function of variations in local runoff. At the end of the release on June 28, flows were reduced in 57 m^3/s (2,000 cfs) increments to 113 m^3/s (±4,000 cfs).

Water temperatures at Bonners Ferry ranged from 7.8° to 15.1°C (46°F to 59°F) between May 1 and the end of the flow test on June 28, 1994 (Figure 2). The mean daily water temperature was 10°C (50°F) for May, 12°C (53.6°F) for June and 17°C (62.6°F) for July, 1994. Maximum water temperatures in July were 19°C (66.2°F).

Adult White Sturgeon Captures

Between March 1989 and December 1994, researchers captured 437 adult fish in 24,238.5 hours of fishing with setline and rod and reel. The catch per hour was 0.10 fish/h for rod and reel and 0.01 fish/h for setlines. Six white sturgeon were captured in baited hoop nets. One fish was captured and released while electrofishing in the Hemlock Bar area (rkm 263.5).

Figure 2. Temperature (C), flow (m3/s) and number of white sturgeon eggs collected in the Kootenai River, Idaho during 1994.



White Sturgeon Tracking

Total telemetry effort for the period January to July 29, 1994 was 418.75 hours. The effort required to monitor sturgeon locations was proportional to the degree of travel of transmitter-bearing sturgeon. Eight hours of monitoring was adequate to locate the 16 fish with ultrasonic transmitters in the month of January. Monitoring progressively increased as the number of fish wearing transmitters increased to 32 and their degree of movement increased. Effort in February was 10% hours, 16 hours in March, 371,E hours in April, and 152¼ hours in May. As sturgeon started retreating to sites in the lower river and Kootenay Lake, the hours of monitoring effort decreased to 121A hours in June and 73¼ hours in July.

We focused our tracking effort on locating late vitellogenic females and males exhibiting reproductive behavior. Tracking effort involved 15 surveys of Kootenay Lake, 16 surveys of the river reach between Kootenay Lake to Creston, British Columbia, 17 surveys from Creston to Porthill, 41 surveys from Porthill to Copeland, 64 surveys from Copeland to Deep Creek, and 31 surveys between Deep Creek to U.S. Highway 95 bridge (Figure 3). In total, 418.75 hours of tracking was expended to monitor 31 active transmitters.

No fish were detected with the fixed data logger at rkm 245.8. Male #565 had advanced the furthest upriver to rkm 243 between Ambush Rock and the Kootenai Tribal Experimental Hatchery on May 24, 1994. Two females, #548 and #574, were at rkm 241.5 near the Kootenai Tribal Experimental Hatchery on May 12 and 13, 1994. The fish exhibiting the greatest movement over time was #550, she moved upriver 37 river kilometers in a 24-hour period, May 12 to May 13, 1994.

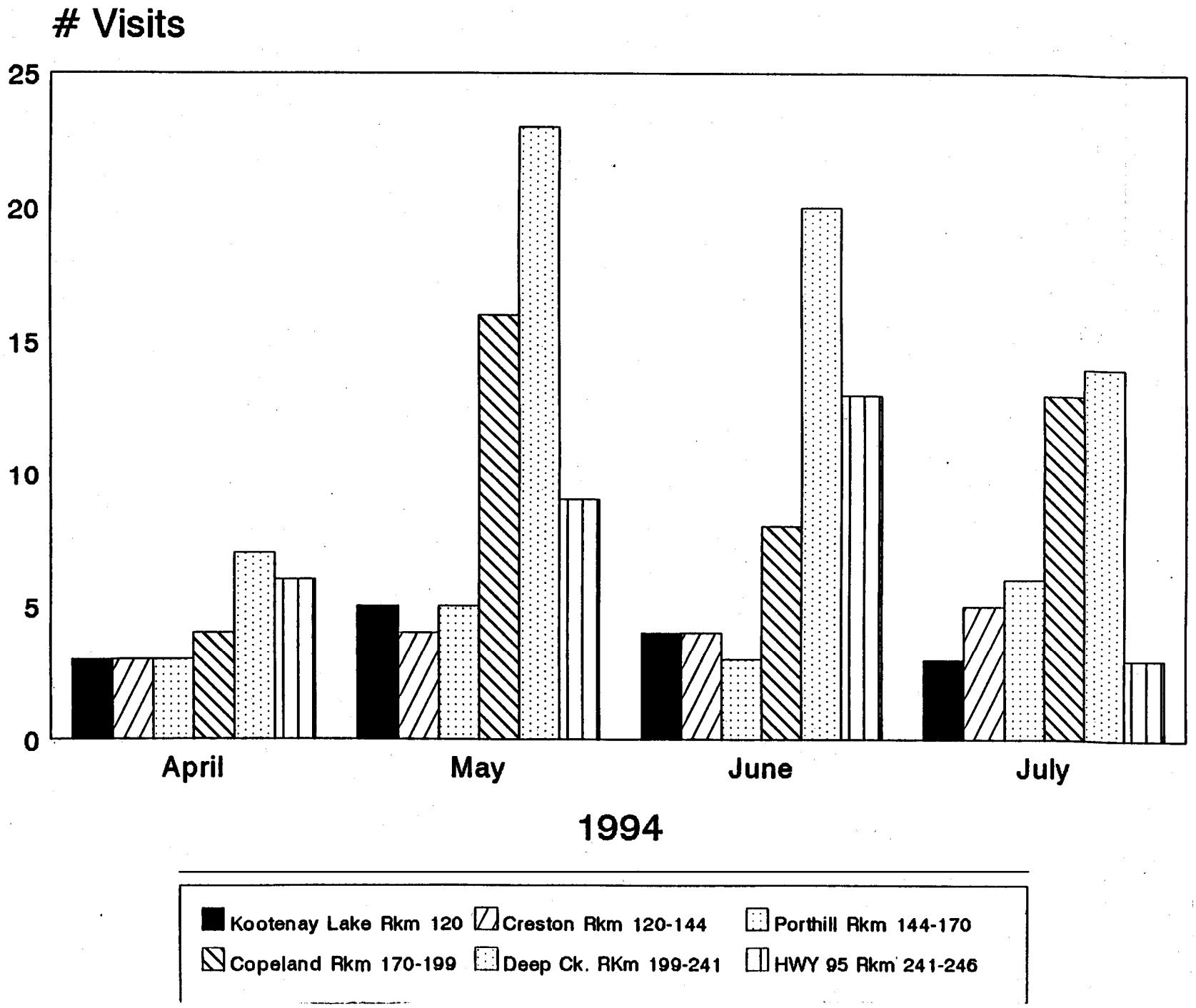
We conducted telemetry at night on specific ripe sturgeon in the Shorty's Island area to see if we could detect actual spawning. Sturgeon exhibited considerable movement within a 0.4 km (.25 mi) range. No evidence was found to support spawning episodes, nor were movements readily different from activities during daylight.

Behavior of Monitored Sturgeon

Of the 31 fish supporting active transmitters, 7 were males and 24 were females. Eleven females and two males overwintered in Kootenay Lake and remained in the lake during the experimental flow release. Of the above complement of lake-dwelling fish, 7 were captured and fitted with transmitters in 1991, 2 in 1992, 7 in 1993, and 1 in 1994. River discharges and upriver locations of 16 of 18 remaining fish are diagrammed in Appendix A. One female (#387) was not located during the 1994 test flow. Another female remained in the lake except for two trips to rkm 182.5.

Twelve fish (8 females, 4 males) traveled upriver of Upper Shorty's Island (rkm 230.1). Seven of these fish (3 females, 4 males) were detected upriver of Myrtle Creek (rkm 237.3). All eggs were collected upriver of the lower end of Shorty's Island (rkm 227.0). Four fish (3 females, 1 male) went upriver to, but not beyond, the large hole at the confluence of Fleming Creek (rkm 225).

Figure 3. Telemetry effort by section on the Kootenai River for April-July, 1994.



Sturgeon Tracked to Locations Upriver of Shorty's Island

Eight females and four males were tracked to locations in the vicinity of sites where fertilized eggs were collected on artificial substrate mats. All but the females #435 and #438 were captured and fitted with transmitters at either Ferry Island (rkm 205) or Rock Creek holes (rkm 215) in March and April of 1994. All 12 sturgeon moved upriver during the spring freshet in late April and during the steadily increasing discharges of early May 1994 (Appendix A). Most of the monitored fish retreated back downriver before the augmented flow reached the targeted 566 m^3/s (20,000 cfs) on June 1, 1994. Female #555 and three males, #565, #574, and #581, remained in the vicinity of Shorty's Island into June before retreating downriver. Male #585 made a downriver run in late June but returned to the Shorty's Island area by mid-July. One of the monitored males, #565, retreated from the group of potential spawners at Shorty's Island and was found with females #163 and #348 in Rock Creek (rkm 215) for a short time before returning to Shorty's Island (Appendix A).

Sturgeon Tracked To, But Not Beyond, Locations Between Ferry Island and Fleming Creek

A potential female spawner, #163, was fitted with a transmitter in April 1994 while located at the confluence. of Rock Creek (rkm 215) (Appendix A). She remained in this vicinity (rkm 210.4-219.5) throughout the entire flow experiment. Another female (#348) processed at Ferry Island in 1994 remained in the Ferry Island area until mid-June. She moved upriver to rkm 224 and remained throughout the study period. One female (#439) fitted with **a** transmitter in Kootenay Lake in 1993 was located in the Rock Creek confluence (rkm 215) during the flow test. Continued presence of this fish's sonic signal at the above location suggested she shed her transmitters.

Fish #583, believed to be a ripe male spawner, was fitted with transmitters at the Rock Creek hole (rkm 215) in April. He moved downriver to British Columbia (rkm 165) and remained there for most of the experimental period.

White Sturgeon Recapture Effort

A total of 529 hours of fishing effort was aimed at recapturing radio and sonic-tagged white sturgeon (Appendix B). Targeted fish were those which had been monitored upriver to and beyond Shorty's Island during the experimental flow test. One hundred and forty hours were spent trying to catch fish #576, and 269 hours of effort toward fish #560. The remaining hours were distributed among six other potential spawners.

Thirteen sturgeon were captured; none were the targeted sturgeon. Data from captured fish was recorded, and they were all released alive after insertion of a PIT tag. Of five fish surgically sexed, there were two males, one female, and two unidentified sturgeon.

Sampling Juvenile White Sturgeon

Between March 1993 and July 1994, 44,333.5 hours of sampling was aimed at collecting juvenile white sturgeon with seven gear types (Table 2). A total of 21 white sturgeon, 5 of which were juveniles, were captured in gill nets, baited hoop nets, setlines, and by rod and reel. Minnow and slat traps did not capture

Table 2. Sampling effort for juvenile white sturgeon in the Kootenai River, 1993 & 1994.

	Upriver of Bonners Ferry			Downriver of Bonners Ferry		
Sampling method	Hours effort	Other fish	Sturgeon	Hours effort	Other fish	Sturgeon
Gillnets	237	4	0	180	17	5
91cm Baited hoopnets [1]	4912.5	41		31,350	211	4
61cm Baited hoopnets	94	13		5378.5	23	0
Minnow traps	283			0	0	
Rod and reel	4.5	4	0	119	12	1
Setlines	174	0	0	579	0	11
Slat traps	150.5	0	0	871.5	0	0
All gear combined	5855.5	62	0	38,478	263	21[2]

[1] March 1993 - July 1994

[2] Four were juveniles from 1991 year class. One was a hatchery reared sturgeon released in 1991.

any fish. Rod and reel sampling caught 1 adult sturgeon and 13 other species. No sturgeon eggs or larvae were found in any of the stomachs of other fish species captured. Six of the 754 predator fish stomachs examined by the Kootenai Indian Tribe contained white sturgeon eggs.

Four juvenile sturgeon were captured in gill nets and one was caught in a hoop net. The location, date, size, and age of the five juveniles are in Table 3.

The recaptured hatchery sturgeon was from 1991 parents, hatched in 1991, and released in the Kootenai River at Ambush Rock August 26, 1992 as part of a study to monitor the release of 104 age 1 fish. The fish was 25.2 cm (9.9 in) total length, 63 g (.14 lb) at release, and was 35 cm (14 in) and 268.3 g (.59 lb) upon recapture and re-release on November 8, 1993. During the 433 days at large, this fish grew 9.8 cm (3.9 in) and 205 g (.45 lb) for an annual rate of 8.3 cm/year (3.3 in) and 173 g/year (.38 lbs/year).

The four wild fish captured in gill nets were collected in 19-20 m (62.3-65.6 ft) of water in the slow flowing section downriver of Bonners Ferry. The fish were all aged at 3 years, part of the 1991 brood year. These fish averaged 40 cm (16 in) and 399 g (.88 lb).

The total composition of species captured by all gear types (Table 4) was 73 fish upriver of Bonners Ferry and 272 fish downriver of Bonners Ferry, Idaho. Suckers and squawfish dominated the catch.

D-Ring Net Sampling

Preliminary data from 277 samples collected with D-Ring nets by the Kootenai Indian D-Ring crew May 18 to July 25, 1994 accounted for 1,215.25 hours of effort at 19 sites (Anders, personal communication). They fished D-Ring nets for 1,184.3 hours on the downriver side of U.S. Highway 95 bridge. The remaining 20.95 hours of sampling occurred at sites upriver from Bonners Ferry. Forty of the D-ring sets were fished on the river for a combined 1,041 hours. Fifty-five of the 277 total sets (30 hours) were surface tows. No white sturgeon eggs or larvae were collected in any samples (Anders 1995, in press).

Research crews from the Idaho Department of Fish and Game made 55 D-ring sets to sieve for larval sturgeon in the water column. Sampling began on June 17 and ended July 6, 1994. All larval searches were conducted downriver of known sturgeon spawning locations. The average depth sampled was 2.7 m (8.7 ft) and ranged from the surface to 10.7 m (35 ft). Nine hundred minutes of seiving 48,163 m^3 (1,700,671 ft^3) of water produced no white sturgeon eggs, larvae, or young-of-the-year.

Beam Trawl Net Sampling

Research crews from Montana Department of Fish, Wildlife and Parks filtered approximately 381,949 m^3 (13,486,900 ft^3) of water from 298 different trawl sets (Table 5). They trawled for a total of 6,082 minutes. No sturgeon eggs or larvae were found; however, 20 eggs and 17 larvae of other fish species were collected. The majority of eggs and larval fish found were northern squawfish, as identified by Montana and Idaho Fish and Game personnel.

Table 3. Location, date, size and age of juvenile sturgeon captured during 1994 in the Kootenai River, Idaho.

No.	Method	Location	Date	Fork Length (cm)	Wt (kg)	Age	Comments
1	Gillnet	Jerome Slough	6/14/94	45.0[1]	.26	III	1991 Year Class
1	Gillnet	Rock Creek	7/16/94	40.5	.54	III	1991 Year Class
1	Gillnet	Rock Creek	7/20/94	41.0	---	III	1991 Year Class
1	Gillnet	Fleming Creek	7/20/94	38.4	---	III	1991 Year Class
1	61cm Hoopnet	Ambush Creek	11/8/93	35.0	.27	III	1991 Hatchery Release

[1] Total length measurement

Table 4. Catch of all species by all gear types upriver and downriver of Bonners Ferry, Idaho 1994.

	Location		
Species	Upriver	Downriver	Total
N. Squawfish	17	94	111
W. Sturgeon	0	21	21
Burbot	1	29	30
Whitefish	7	12	19
Peamouth	10	3	13
Rainbow	1	4	5
Bull Trout	1	5	6
Sucker (Fine)	8	54	62
Sucker (B-lip)	16	27	43
Sucker (C)	12	16	28
Pumpkinseed	0	2	2
Brown Bullhead	0		2
Bluegill	0		1
Yellow Perch	0	3	
TOTAL	73	273	346

Table 5. Summary of beam trawl effort in the **Kootenai River, Idaho, 1994.**

Trawl	rkm 245.7[1]	rkm 228-230[2]	All other areas	<566 m^3/s	>566 m^3/s	Activ Traw1[3]
M^3 Filtered	245,406	77,128	59,415.	120,630	261,319	13,78
Minutes	2119	2338	1625	1296	4915	129

[1] Permanent sites at the railroad bridge.
[2] Permanent sites near Shorty's Island.
[3] Active trawl includes trawls while anchored with trawl fishing the water column as opposed to on the bottom of river.

Artificial Substrate Mat Sampling

Mat samples totaling 1,940 were collected in the Kootenai River: 508 in the lower Shorty's Island section (rkm 228.0-230.0), 311 in the upper Shorty's Island section (rkm 230.1-233.0), 413 in the Myrtle Creek section (rkm 233.1-238.0), and 708 in the Deep Creek section (rkm 238.1-245.6) (Table 6). The total sampling time was 57,630.2 hours in all sections. Average depth for all mats was 7.7 m (25.3 ft) and 8.5 m (27.9 ft) for mats that collected eggs.

Of 213 white sturgeon eggs collected from substrate mats during 1994, 135 were viable, 9 were not staged, 14 were unstageable, and 55 were dead (Table 7; Appendices C_2, and C_3). The majority (112 eggs) were collected in the upper Shorty's Island section from rkm 230.1-233.0. Sixty-three were collected in the lower Shorty's Island section (rkm 228.0-230.0). Thirty-eight eggs were collected in the Myrtle Creek section (rkm 233.0-238.0). No eggs were collected in the Deep Creek section.

The three largest egg collections from individual mat samples took place May 15 at rkm 230.3 (71 eggs), May 16 at rkm 237.5 (35 eggs), and May 26 at rkm 229.3 (28 eggs). Other mat samples yielded from 1-8 eggs each (Figure 2 and Table 7).

Surface velocities at egg collection sites ranged from .06-.85 m/s (.2-2.8 ft/s) and averaged 0.43 m/s (1.42 ft/s). Velocities near the river substrate ranged from .09-.68 m/s (.3-2.2 ft/s) and averaged .28 m/s (.93 ft/s). Eggs taken to the Kootenai Experimental Hatchery or placed in the river for observation of development became coated with fungus briefly after collection and died.

The habitat at the Myrtle Creek egg collection site and the site of the most likely corresponding spawning episode was over sand substrate, no sign of upwelling current, river velocities of .4 m/s (1.31 f/s), 5.8 m (19 ft) of depth, and water at 8.6°C (47.5°F). Depth in the Shorty's Island area was more like the lower Columbia River standard, but velocities were .4 m/s (1.31 ft/s) rather than the 1+ m/s (3.2 ft/s) standard, temperature was 9.2°C (48.5°F) rather than 10°C (50°F).

Age and Growth of Adult White Sturgeon

Ages of 18 sturgeon in the 107-137 cm (42.8-54.8 in) length category ranged from 20 to 32 years (Table 8). These smaller adults were all spawned in 1974 and in years prior to Libby Dam.

Growth of Recaptured Adult Sturgeon

Over the five-year period from 1978 to 1982, 380 adult white sturgeon were captured by State of Idaho Department of Fish and Game personnel (Partridge 1983). Fish were individually identified with Floy dart tags. Growth rates were calculated using measurements from 44 fish that were captured at least twice. Twelve fish were captured three times and two fish were caught four times. Growth averaged 3.3 cm (1.32 in) per year (n=44, SD = 6.2). Intervals between measurements ranged from 1 to 1,237 days. Some calculated growth rates were negative due to measurement errors associated with unanesthetized fish. Growth ranged from -7.3 to 36.5 cm (-2.9 to 14.6 in) per year.

Table 6. Distribution of artificial substrate mat sampling effort for sampling white sturgeon eggs in the Kootenai River, Idaho, 1994.

River Section	Downriver rkm	Upriver rkm	Number of Mat Samples	Average Depth (M)	Total sample hours	Number white sturgeon eggs
Lower Shorty's Island	228.0	230.0	508	9.5	15,222.1	63
Upper Shorty's Island	230.1	233.0	311	8.0	6,753.3	112
Myrtle Creek	233.1	238.0	413	7.7	11,494.0	38
Deep Creek rkm	238.1	245.6	708	6.2	24,160.9	0
Total mat effort	228.0	245.6	1,940	7.8	57.630.2	213
Total effort on mats with eggs	228.0	237.5	37	8.4	936.8	213

Table 7. Collection date, location and stage of stageable white sturgeon eggs collected on substrate mats during 1994.

Date	Total eggs	Stage 12	13	14	15	16	17	18	19	20	21	22	UNS	DEAD
Lower Shorty's Island Section														
5/16	2													2
5/18	6													6
5/20	1													1
5/25	4									2		2		
5/26	28							14					8	6
5/28	4							1			1		2	
5/30	6													6
5/31	1												1	
6/4	1							1						
6/5	3						1					2		
6/8	6													6
6/11	1													1
Upper Shorty's Island														
5/15	71	3	8	32	9	4	3							12
5/16	6													6
5/17	1													1
5/18	1								1					
5/24	2													2
5/27	1												1	
5/30	2													2
6/3	1						1							
6/4	6				1		2			1	2			
6/4	8						7	1						
6/8	1													1
6/11	3							2						1
6/15'	2													
6/20'	7													
Myrtle Creek Section														
5/16	35					1	2	5	17	6	2	1		1
5/17	1													1
•5/28	1												[1]	
5/30	1												[1]	
Total	213	3	8	32	10	5	16	24	18	9	5	5	14	55

[1] These eggs were not staged at report time.

Table 8. Age and size of 18 white sturgeon captured in 1994

Tag number	Fork length (cm)	Weight (kg)	Age
7F7DOB6EOB	107	7	20
7F7DOC3E3E	112	18	20
7F7D000A5A	124	14	24
7F7D000E35	112	7	23
7F7F426B49	123	20	32
7F7F116E22	111	9	20
7F7D031F5D	113	12	24
7F7DOB6731	120	11	27
7F7DOF7727	119	20	30
7F7DOF6262	120	20.5	29
7F7D111F50 [1]	102	13.6	32
7F7D14OD1F [1]	130	14	25
7F7F374F07 [1]	123	11	21
7F7DOD5C29.	119	13	24
7F7D0A4330 [1]	113	9	20
7F7D113128	137	24	23
7F7DOD783D	123	11	22
7F7D0D6372			20

1 Fish which had fin samples removed and aged on previous capture dates

Over the six-year period from 1989 to 1994, 604 adult fish were caught. Fish were identified with Flay tags, PIT tags, or both. Growth rates were calculated from 88 recaptures with known fork lengths and 87 recaptures with known total lengths. Growth rates using both fork and total length averaged 2.2 cm (.88 in) per year (SD = 5.5 for FL and 7.3 for TL). Growth rate of recaptured white sturgeon (40 - 80 cm FL) was 5.4 cm FL/year in the upper reaches of Lower Granite Reservoir (Lepla, 1994). Measurement intervals ranged from 26 to 1,900 days. The maximum measurable (FL) annual growth was 31.9 cm (12.8 in).

Twenty-two of 962 adult fish were captured in both periods of the study (1978-1982 and 1989-1994). Nine were caught three times, five were caught four times, two were caught five times, two were caught six times, and one fish was captured seven times. Total growth for these fish averaged 3.2 cm (1.28 in) per year (SD = 1.2). Intervals between multiple captures ranged from 2,610 to 5,131 days. Calculated growth ranged from 0.8-5.5 cm (.32-2:2 in) per year. These fish should have had ample time between capture and recapture to compensate for any influence of the fish's behavior due to the stress of handling and marking.

Hatchery Reared Juvenile Release

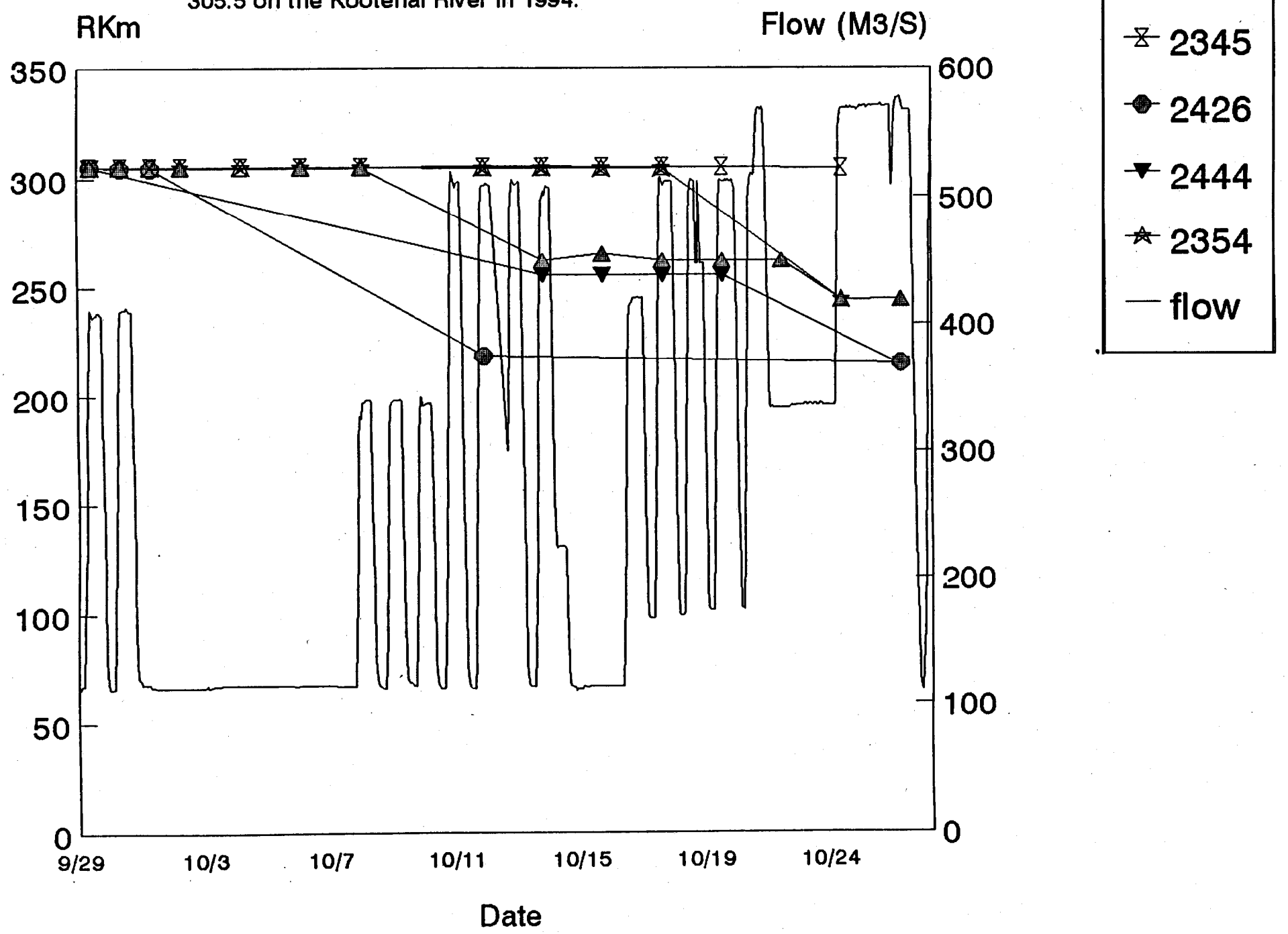
Ten hatchery reared juvenile sturgeon were released on September 29, 1994 in groups downriver of Kootenai Falls, Montana (rkm 305 to 310.5). By October 26, 9 of the 10 fish were located 60 to 96 kilometers downriver between Rock Creek (rkm 214.3) and Ambush Rock (rkm 244.6). Fish #2345 from the rkm 305.5 release group was located at Ambush Rock (rkm 244.5) on November 14, 1994. Travel patterns of individual fish and corresponding river flows are shown in Figure 4.

During the day of September 29 and the day following the release on September 30, river flows peaked between 112 and 414 m^3/s (3,955 and 14,619 cfs) within a 24-hour period. Two fish (#2336 and #2327) released at rkm 309.3 and rkm 309.8, and one fish (# 2444) released at rkm 305.4, moved downriver within the first two days. Fish #2426, released at rkm 305.4, had moved downriver on the third day. Three of these four fish (#2336, #2327, #2426) were located between Rock Creek (rkm 215.7) and Fleming Creek (rkm 227.2) by October 17. They were still in this area at the end of October. The fourth fish (#2444) was located on October 14 near Hemlock Bar (rkm 255.8) where it stayed through October 20. On October 26 it was located at Rock Creek (rkm 215.3). The second major movement of fish #2444 occurred during a power peaking event between October 17 and October 21 that ranged from 114 to 566 m^3/s (4,025 to 24,397 cfs) within a 24-hour period.

Two fish (#2264 and #2255) released at rkm 310.4 and rkm 310.5, and one fish (# 2363) released at rkm 305.4, moved out of their release sites between October 8 and October 14. This movement occurred coincidental to fluctuations of discharge from 114 to 513 m^3/s (4,025 to 18,114 cfs) within 24-hour periods. Fish #2264 was located at Fleming Creek (rkm 226.6) on October 12 and fish #2255 was located at Ambush Rock (rkm 244) on October 16 where they remained through the end of October. Fish #2363 was located at Hemlock Bar (rkm 262.2) on October 14. It had moved to Ambush Rock (rkm 244.6) between October 22 and 24 during which time flows had stabilized for two weekend days at 335 m^3/s (11,829 cfs). During the next week, the peaking events resumed from 336 to 578 m^3/s (11,864 to 20,410 cfs).

The remaining fish (#2273) released at rkm 310.1, and one of the two (#2354) released at rkm 305.4, moved out of the release sites by October 24. Fish #2273 moved out after October 20 and was located at Hemlock Bar (rkm 260) on October 22. It was next located above Rock Creek (rkm 218.7) on October 26, a distance of 41.3 km (25.7 mi). The first major movement of #2273 occurred

Figure 4. River flows and movements of juvenile white sturgeon released at rkm 305.5 on the Kootenai River in 1994.



while flows were stable at 335 m^3/s (11,829 cfs). The second major movement of fish #2273 occurred when discharge from Libby Dam peaked at 567 m^3/s (20,021 cfs) from October 24-25.

DISCUSSION

Our evaluation of the flow conditions in the Kootenai River in 1994 revealed white sturgeon did spawn, although it is uncertain whether larva and juveniles were produced. The presence of fertilized eggs in areas where reproductively mature sturgeon were known to occupy was encouraging. The lack of evidence of any larvae from the 1994 spawning episodes, or noticeable numbers of recruits from previous years, accentuated the need for continued search for sturgeon recruits and the need to evaluate a flow pattern similar to years known to produce recruits to the population.

The elimination of capturing brood stock on the spawning site appeared to have eliminated the downriver retreat evident of monitored adult spawners. Also the elimination of peaking power flows may have helped. Russian biologists noted similar phenomenons and attributed the failure to spawn as a stress reaction to false upriver clues in response to discharge peaks from power production (Votinov and Kasyanov 1979).

Concurrent with the evaluation of the spawning response of sturgeon to the "flow test" of 1993 was a brood stock collection by the crew from the Kootenai Experimental Hatchery. The primary source of brood stock was from the group of migrants at the Shorty's Island hole. A total of 64 sturgeon were landed and examined for maturity. Four females and 12 males were taken to the hatchery as potential brood. No more than 3 females and 6 males were held at any one time at the facility. From this group, 2 males and 1 female spawned (Unpublished data, Kootenai Experimental Hatchery). All these fish were eventually released after insertions of PIT tags. Female #437 was equipped with a sonic transmitter. This transmitter-bearing fish immediately traveled downriver to Kootenay Lake. One male (no sonic transmitter) was captured two times on the same day. A review of the data base for all sturgeon captures indicated that males released in a healthy condition may stay in the general area of capture and release. We believe the stress of handling may alter the sturgeon natural spawning behavior.

Based on the estimated population of 880 sturgeon in 1991, a 3.74% annual mortality rate, a reproductive component of 7% of the females and 30% of the males each year (Apperson, 1992), we estimated a total of 29 reproductive females and 122 males in 1993. The 64 fish landed for potential brood stock could have represented 42% of the 151 reproductive parents in the Kootenai River in 1993. Because no brood stock were collected in 1994, we believe the migration and spawning behavior of sturgeon in 1994 was more natural, and more indicative of the flow test rather than a reaction to the human impact associated with capturing fish on the spawning grounds.

The collection of fertilized eggs at both Shorty's Island and near the confluence of Myrtle Creek suggested a positive reproductive response to the 1994 flow test. We believe the flow configuration and timing to be the primary reason for spawning. We do not believe the additional effort in mat sampling (33,461 h in 1994 verses 9,083 h in 1993) was responsible for the egg collections since the same areas were sampled in 1993. Shorty's Island area was previously considered a staging area where pre-spawning behavior occurred prior to sturgeon advancing upriver. The eggs we collected in the Kootenai River were in slack water with mean flows of 0.4 m/s and over a sand bottom. Based on Parsley et al. 1989, this area does not meet the habitat requirements for spawning. Spawning habitat was defined for sturgeon in the lower Columbia River as having velocities

>1 m/s (3.2 f/s), cobble to boulder sized substrate, depths of > 3 m (9.8 ft), and a preferred temperature range of 10°C to 18°C (50°F to 64°F).

We assumed our inability to collect larvae or young-of-the-year sturgeon was because few, if any, of the fertilized eggs hatched. Our procedures mimicked those used successfully on the lower Columbia River. One of the requirements for successful egg development was a substrate composition of cobble to boulder sized material where eggs were less vulnerable to predation or suffocation. The substrate viewed by the authors while scuba diving downriver of Bonners Ferry was predominately sand and silt with considerable deposits of logs and rootwads. The river section from Bonners Ferry to Montana is a mix of gravel, cobbles, and bedrock with higher velocity currents, and would therefore appear to be better spawning habitat.

Our observation of fertilized eggs showed considerable accumulations of sand particles attached to the egg surface. We suspect the sand particles have little to do with suppressing hatching, but do feel eggs are more vulnerable to predation in the river reaches downriver of Bonners Ferry.

The best evidence of recruitment to the population since the operation of Libby Dam was the collection of 35 sturgeon, whose age was back-calculated to 1974 and four fish from the 1991 brood year. The most notable environmental circumstance associated with the 1974 and 1991 was the peak discharge of 1,549 m^3/s (54,700 cfs) in 1974 and 1,325 m^3/s (46,800 cfs) in 1991.

Thirteen fertilized eggs were collected on mats placed over cobble substrate at rkm 245 in the Bonners Ferry area in 1991. In 1994, we captured and released four juvenile sturgeon that appeared to be wild fish from the 1991 brood year. This is the best evidence we have suggesting sturgeon recruits are possible given the right flow conditions. Anders (Kootenai Indian Tribe biologist, personal communication) has stated these four fish could have been escapes from the Kootenai Experimental Hatchery.

We recommend sturgeon spawning flows .for 1995 begin by incremental increasing the flow 57 m^3/s (2,000 cfs) per day to a minimum of 991 m^3/s (35,000 cfs). We further recommend no load following. Our goal is to stimulate sturgeon movement and spawning in a manner mimicking historic river conditions known to produce year classes of sturgeon. The 991 m^3/s (35,000 cfs) recommendation is a compromise from the 1,416 to 2,549 m^3/s (50,000 to 90,000 cfs) flows occurring in years of recruit production. Our concern was to minimize the impact of high river volumes on lands adjacent to the river. The recruits generated during high discharge river conditions in 1991 suggested river discharges encouraged fish to spawn upriver of Bonners Ferry over substrate of a cobble and bedrock. This may have promoted hatching as opposed to the spawning sites sturgeon selected at the lower 1994 discharge. Our hope is that higher flows will stimulate spawners to move upriver of Bonners Ferry and release eggs over a clean cobble substrate.

RECOMMENDATIONS

1. We recommend a flow test in 1995 to evaluate movement and spawning behavior of sturgeon in the Kootenai River with the following criteria:

   (a) In conjunction with or following the "local" lowland run-off in early May 1995, flows should not diminish below 425 m^3/s (15 kcfs) at Bonners Ferry, Idaho.

   (b) Beginning approximately May 1-10, 1995 or as determined by telemetry of adult white sturgeon, flows should increased by 57 m^3/s (2,000 cfs) increments until 991 m^3/s (35 kcfs) is reached.

(c) Maintain at least 991 m^3/s (35 kcfs) for 46 days (May 15-June 30, 1995) or as determined by the locations of monitored white sturgeon.

(d) Discharges should be decreased in increments of 57 m^3/s/day (2,000 cfs/day) to 425 m^3/s (15 kcfs) over a 10 day (June 30-July 10, 1995) period.

(e) Flows should remain at 425 m^3/s (15 kcfs) for 15 days (July 11-July 26, 1995) during hatching and early life history of juvenile white sturgeon.

(f) No load following should occur during sturgeon migration, spawning, and hatching stages (May 1 to July 26).

(g) Minimum flow reduction from 425 m^3/s (15 kcfs) in 57 m^3/s/day (2,000 cfs/day) increments to no lower than 4,000 cfs for the balance of the year.

2. Effort to capture sturgeon eggs should be intensified by locating artificial substrate mats at sites near the confluence of Rock Creek, Fleming Creek and Ferry Island.

3. Gill nets should be fished in an attempt to capture juvenile sturgeon. More diverse habitats, including Kootenay Lake should be sampled.

4. Intensify larval search of areas downriver of sites where sturgeon eggs are collected.

5. Brood stock for hatchery production should not be taken from the limited spawning stock available in the Kootenai River.

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David Overman
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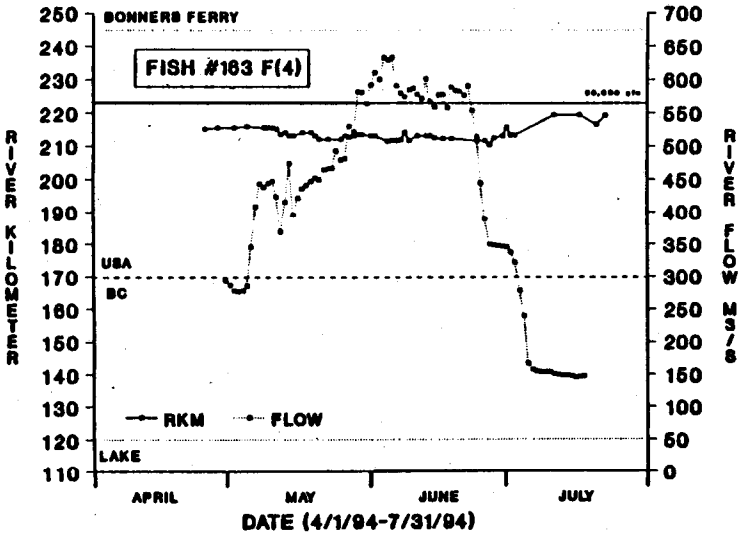
A P P E N D I C E S

Appendix 1. Description of the movement of white sturgeon with transmitters in the Kootenai River in 1994. Letter and number in parentheses identifies gender and stage of sexual development. Fish not responding to the 1994 flow test were not included in the appendix.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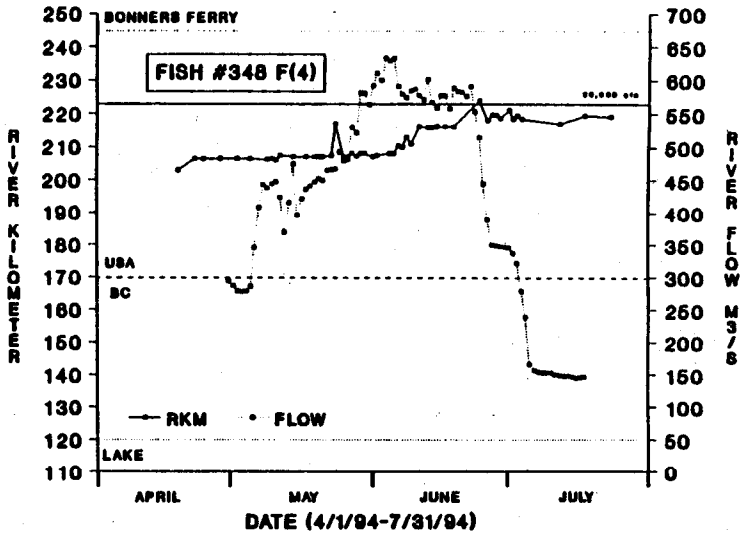
BC
LAKE
RKM
FLOW
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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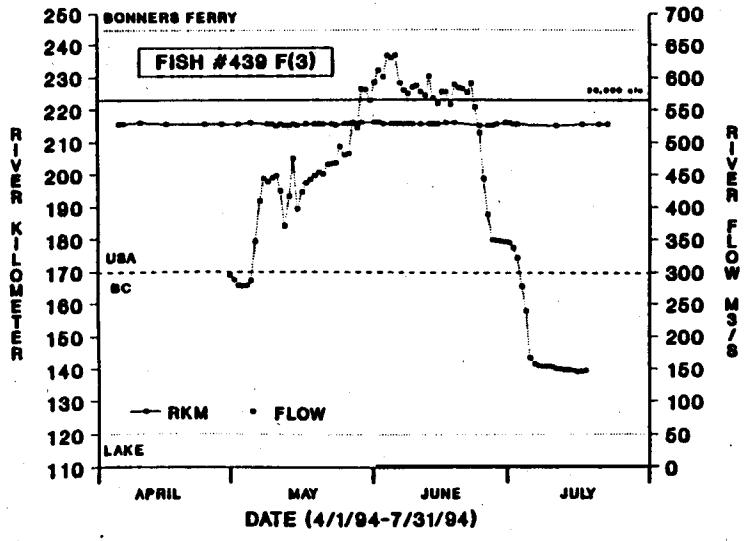
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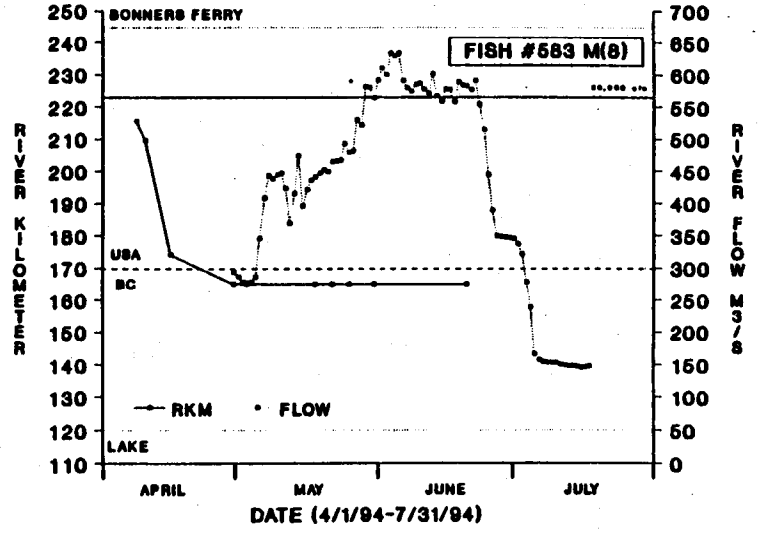
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JUNE
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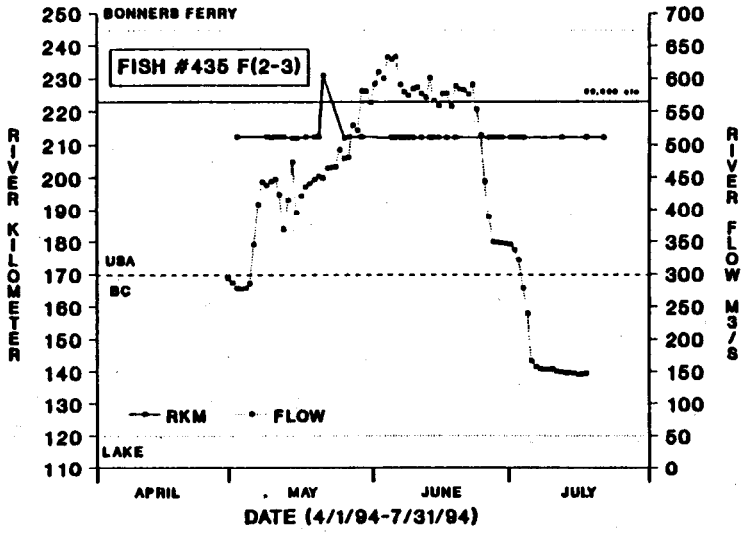
DATE (4/1/94-7/31/94)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MAY
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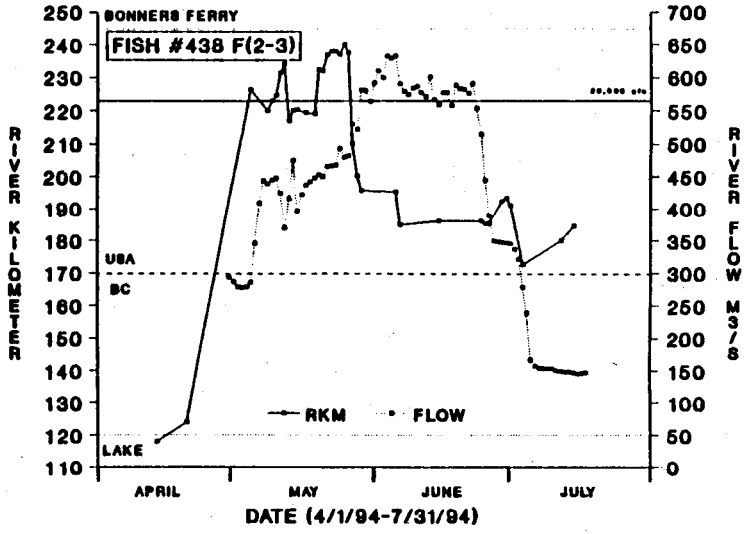
JULY
DATE (4/1/94-7/31/94)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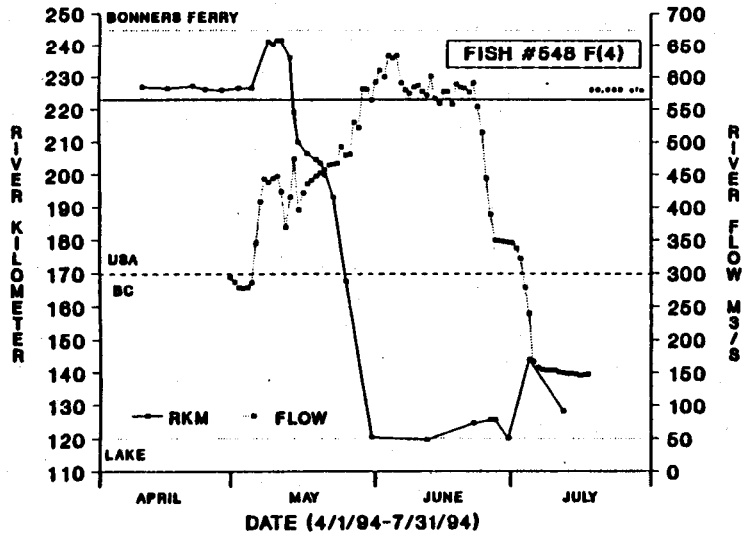
FISH #438 F(2-3)
RIVER KILOMETER
RIVER FLOW M3/S
USA
BC
LAKE
RKM
FLOW
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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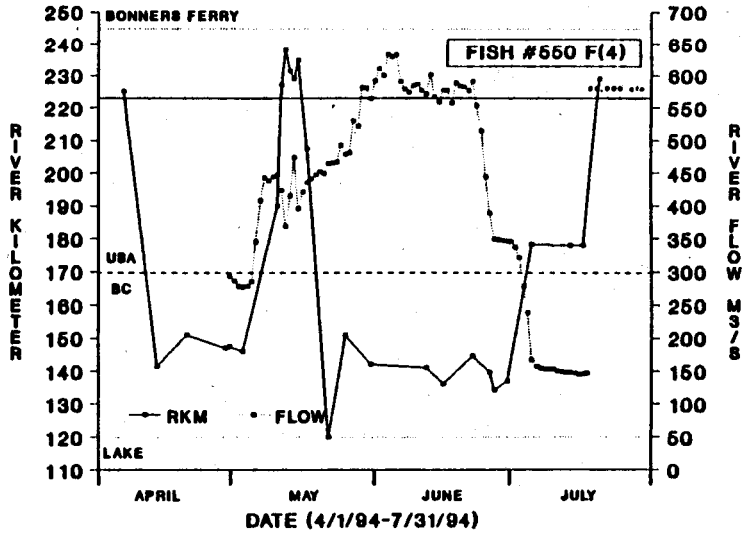
FISH #548 F(4)
RIVER KILOMETER
RIVER FLOW M3/S
USA
BC
LAKE
RKM
FLOW
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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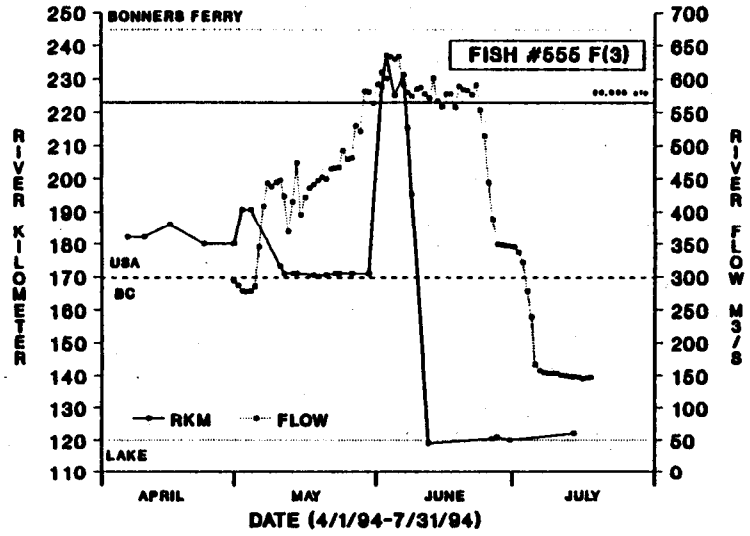
FISH #550 F(4)
RIVER KILOMETER
RIVER FLOW M3/S
USA
BC
LAKE
RKM
FLOW
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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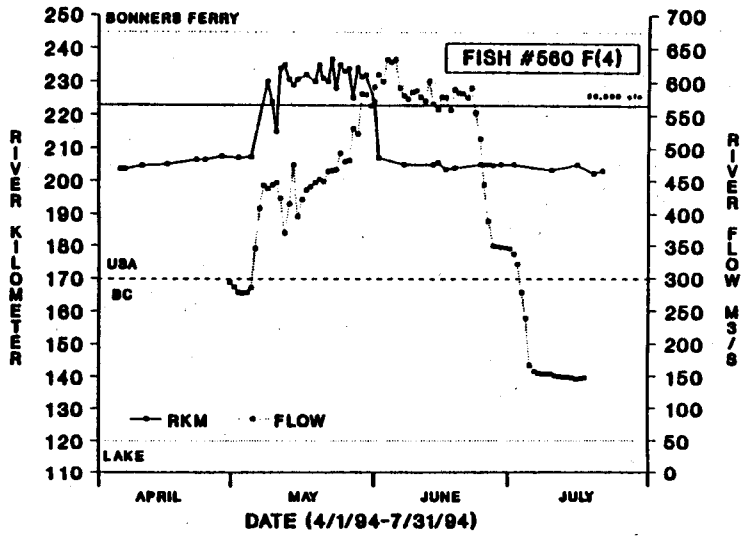
USA
BC
LAKE
RKM
FLOW
RIVER KILOMETER
RIVER FLOW M3/S
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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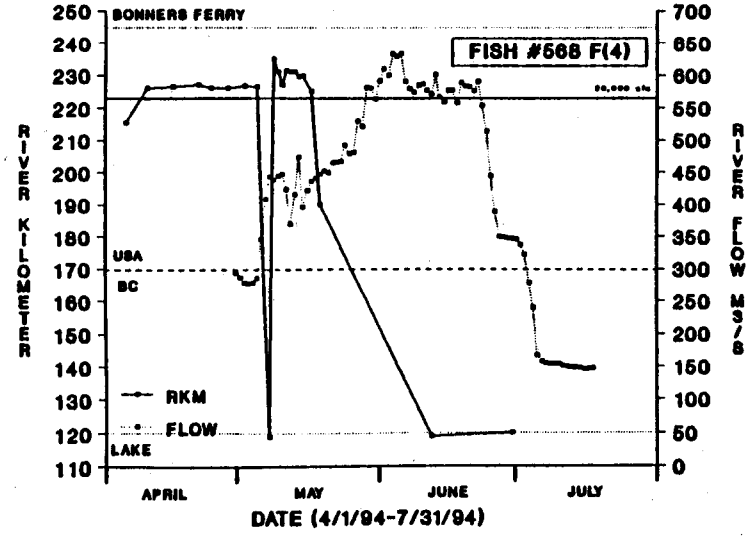
USA
BC
LAKE
RKM
FLOW
RIVER KILOMETER
RIVER FLOW M3/S
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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USA
BC
LAKE
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APRIL
MAY
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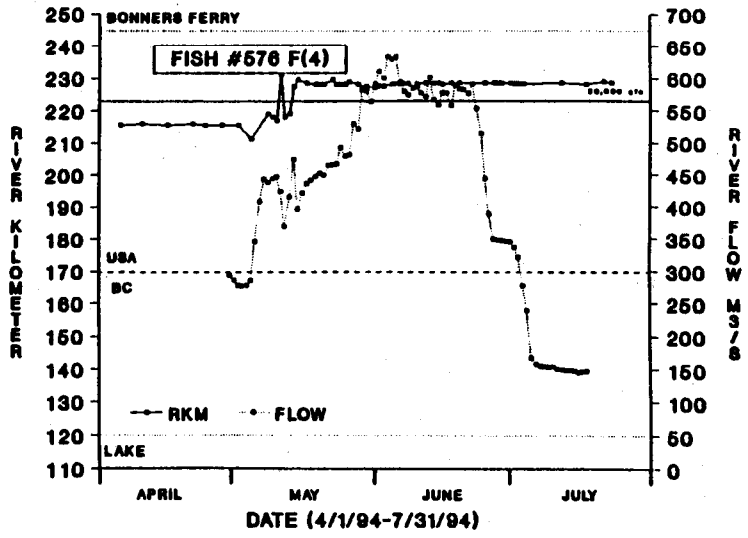
JULY
DATE (4/1/94-7/31/94)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USA
BC
LAKE
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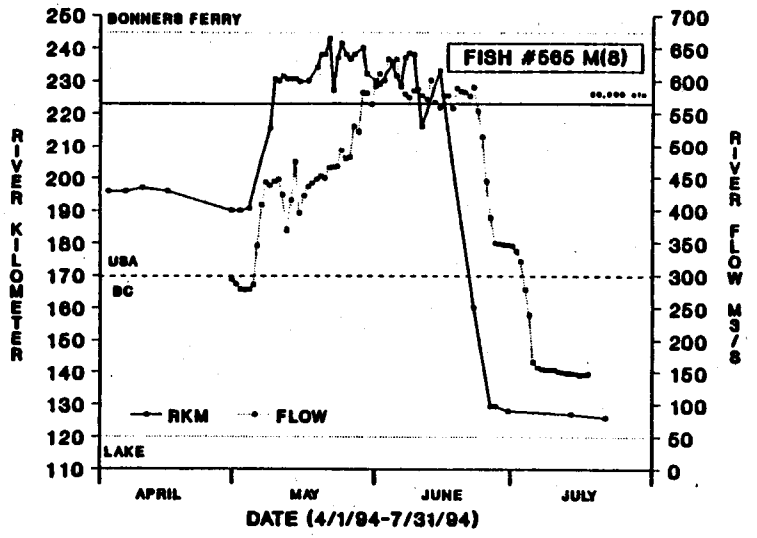
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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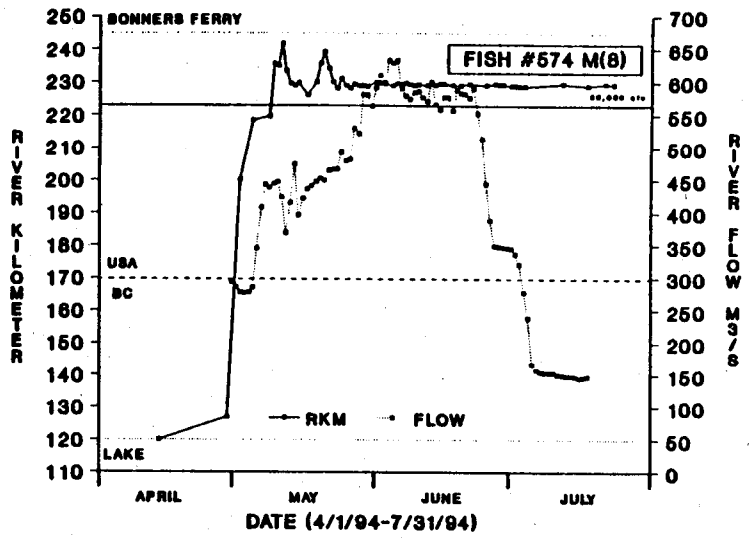
USA
BC
LAKE
RKM
FLOW
RIVER KILOMETER
RIVER FLOW M3/S
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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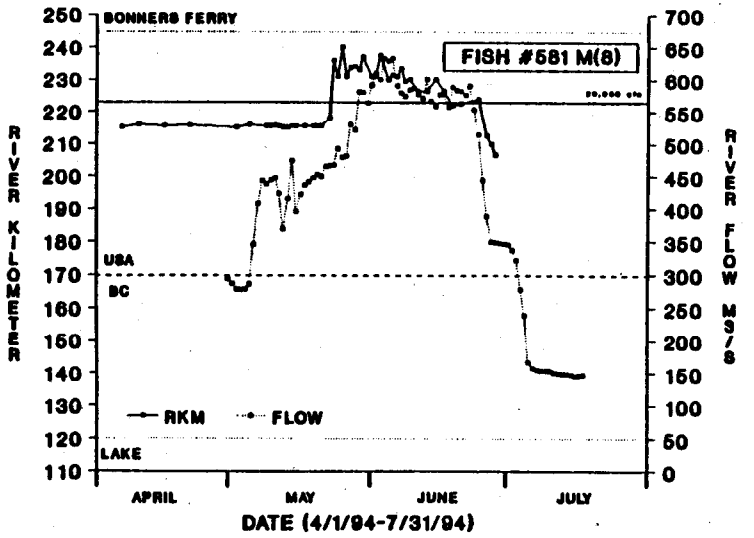
FISH #574 M(8)
USA
BC
LAKE
RKM
FLOW
RIVER KILOMETER
RIVER FLOW M3/S
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)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FISH #581 M(8)
USA
BC
LAKE
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FLOW
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RIVER FLOW M3/S
APRIL
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JUNE
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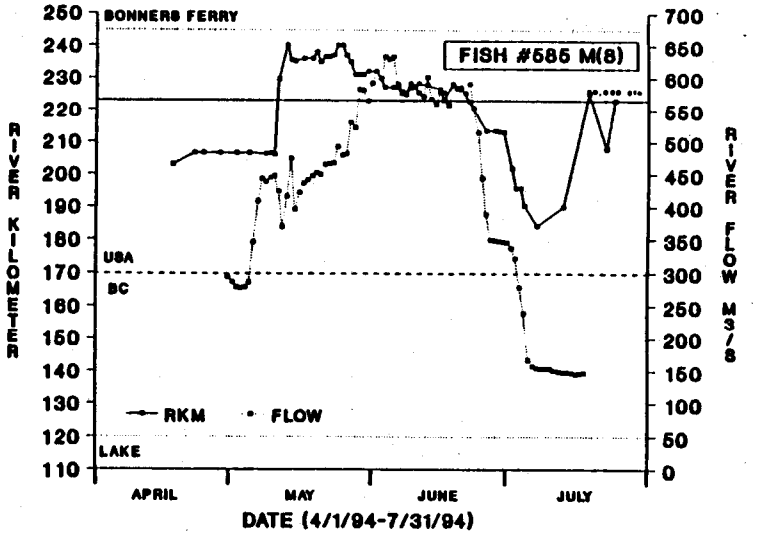
DATE (4/1/94-7/31/94)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FISH #585 M(8)
USA
BC
LAKE
RKM
FLOW
RIVER KILOMETER
RIVER FLOW M3/S
APRIL
MAY
JUNE
JULY
DATE (4/1/94-7/31/94)

Appendix 2. Recapture effort for radio and sonic tagged white sturgeon, Kootenai River and Kootenay Lake, 1994.

Date	Target fish (caught?)	Location	No. rods	No. setlines	Total effort	No. sturgeon caught
6/08/94		189.1			20	0
6/10/94		Shorty's Island			16	1
6/22/94		Shorty's Island			20	1
6/23/94		Shorty's Island			24	
7/31/94	576 (No)	228.7		2	48.5	2
7/31/94	576 (No)	229.2		1	24.5	0
7/31/94	576 (No)	229.3		1	25	0
8/9-8/10/94	576 (No)	228.6-229.5	3		36	0
8/10/94	576 (No)	215	3		6	0
8/19/94	560 (No)	205	10		100	3
8/19/94	560 (No)	206		3	82.5	
8/20/94	560 (No)	205		3	69	
8/20/94	560 (No)	207		1	17.5	
9/14/94	438 (No)	119	8		20	0
9/14/94	550 (No)	121	8		20	0
Total					529	13

Appendix 3. Number of mats, eggs, stage of eggs, day of collection and location of transmitted fish in Kootenai River, 1994.

Date	Number eggs	Number mats	Number transmitted fish M		Stage
rkm 236.0-237.5: Myrtle Creek					Average hours = 25.94 Average 22 feet Average velocity = 1.35 f/s for 2 measurements
5/16	35	1	1[1]	2	dD 14 16 17 18 19 20 1 1 2 5 1 6 2 1
5/17	1	1			Dead
5/28	1	1	2	1	Unstageable
5/30	1	1			Unstageable
Total		38	4		3 3
rkm 230.3-230.9: Upper Shorty'sIsland					Average hours = 35.1 Average depth = 27.1 Average velocity = 1.31 F/S for 4 measurements
5/15	71	5	4	3	Dead 12 13 14 15 16 12 3 8 32 9 4
5/16	6	1			Dead
5/17	1	1			Dead
5/18	1	1			19 1
5/24	2	1	2	4	Dead
5/27	1	1			Unstageable
5/30	2	1	1	3	Dead
6/03	1	1			17 1
6/04	14	1	0	3	15 17 18 20 21 1 9 1 1 2
6/08 .	1	1	1	2	Dead
6/11	3	1			Dead 18 1 2
6/15	2	1			Not staged (2)
6/20	1	1			Not staged (7)
Total	**112**		**17**		

Appendix 3. Continued.

[1]

rkm 228.7-230.0:	Lower Shorty's Island		Average hours = 35.89 Average depth = 31.1 feet Average velocity = 1.1 F/S	
5/16	2	1	Dead	
5/19	6	1	Dead	
5/20	1	1	Dead	
5/25	4	1	20 22 2 2	
5/26	28	2	Unstageable 8	Dead 18 6 14
5/28	4	2	Unstageable 2	18 21 1 1
5/30	6	1	Dead	
5/31	1	1.	Unstageable	
6/04	1	1	18 1	
6/05	3	1	17 22 1 2	
6/08	6	3	Dead	
6/11	1	1	Dead	
Total		63	16	

[1] **One male was located in this section on 6/6/94**

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Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

Steven M. Huffaker

Steven M. Huffaker, Chief
Bureau of Fisheries

Al Van Vooren

Al Van Vooren
Fishery Research Manager